THURSDAY, FEBRUARY 13, 1908.

IS MARS HABITABLE?

Is Mars Habitable? A Critical Examination of Prof. Lowell's Book, "Mars and its Canals," with an Alternative Explanation. By Dr. Alfred Russel Wallace, F.R.S. Pp. xii+110. (London: Macmillan and Co., Ltd., 1907.) Price 2*s.* 6*d.*

IN the year 1903 Dr. Wallace published an interesting and fascinating volume entitled "Man's Place in the Universe," a book which created quite a large perturbation in the thinking world. In it he marshalled together a great number of lines of astronomical research, pointed out the deductions which had generally been made from them, and by weaving them together in a masterly way, drew some very definite conclusions from them.

These conclusions he "claimed to have shown to have enormous probabilities in their favour," and two of them, which need only here be mentioned, were as follows:—

(1) That no other planet in the solar system than our earth is inhabited or habitable.

(2) That the probabilities are almost as great against any other sun possessing inhabited planets.

Not only, then, was a wet blanket thrown over many of our favourite dreams relating to the probable doings of living creatures in other worlds, but quite a shock was received when our near neighbour Mars was ruled out of court and declared to be uninhabitable!

We had all become accustomed to regard the changes of hue on the planet's surface as due to the varying tints of waxing and waning vegetable growth. We pictured to ourselves the great ice caps melting away under the heat rays of the approaching summer sun. The gemination of the canals and the later duplication of some of them were the means of making the best use of the water after its release from the poles, and the oases served as distributing centres. These and many other variations of absorbing interest all tended to indicate a world of change, very different from the serenity on, let us say, the moon, but more approximating to those of the earth when seen from afar.

If we are to take the view of the writer of this book, such changes must be looked on rather as signs of death than of life, since water, he says, there is none.

During the last decade or more the planet Mars has received a considerable amount of attention. By the energetic, persevering, and painstaking astronomer Prof. Lowell, every portion of the planet's surface has been under close observation, and the surface features have been chronicled on nearly every occasion when favourable opportunities presented themselves.

It is not too much to say that just as the name of Schiaparelli is now, and will always be, identified with the planet Mars, so will that of Lowell be handed down to posterity for his magnificent consecutive series of observations.

In the year 1905 Prof. Lowell published a very valuable volume describing in great detail, and copiously illustrated with sketches and charts, the observations made by him at the oppositions of 1894, 1896, 1898, 1901, and 1903.

In 1906 he published a volume which was intentionally devoid of technicalities. This was meant to contain a summary of the main results, derived from the discussion of all the data, and his own deductions as to the probable cause or causes of the surface features and their changes. He was led finally to make the following statement with regard to the habitability of Mars:—"That Mars is inhabited by beings of some sort or other we may consider as certain as it is uncertain what those beings may be."

This very definite statement, made after the issue of Dr. Wallace's book to which reference above has been made, has called into being the present small volume by the same author. Although, as we read in the preface, it was commenced as a review article on Prof. Lowell's recent book, it became so extended that it was considered expedient to publish a more detailed examination of the various physical problems involved in order to give a complete presentation of the opposite view held by Prof. Lowell.

In directing attention to the contents of this book it is not proposed to enter into each point of the arguments dealt with, but it will be sufficient to refer briefly to some of them.

The first two chapters are devoted to a general survey of the observations of Mars made by early workers, concluding with those made by Prof. Lowell. With regard to the last-mentioned, the author pays a high tribute to the technical skill and persevering labour of Prof. Lowell, and, while accepting all his observations as valid, only parts company with him "as regards the startling theory of artificial production which he thinks alone adequate to explain them."

The two main topics dealt with in chapter iii. are the questions of the elaborate system of the canals and the water supply. The author takes the view that if the surface of the planet is so wonderfully smooth and level as Prof. Lowell states it to be, then the great network of straight canals could possibly have been constructed by intelligent beings for irrigation purposes. But he points out emphatically here that, if it were so smooth, then such a system would be quite unnecessary, as the water would naturally irrigate as much of the surface as it could reach. If it be admitted for a moment that the polar caps are frozen water, he joins with the late Miss Clerke in the view that the excessively scanty supply of water, coupled with the loss through evaporation, could not possibly serve the innumerable canals.

As the habitability of Mars depends on the presence of water, the question of the evidence for the presence or absence of water vapour is dealt with in chapter iv. Dr. Wallace first directs attention to the observation of the melting polar caps, and the deduction made by Prof. Lowell that this melting and re-forming affirm the presence of water vapour in the atmosphere. It will be remembered that Prof. Lowell observed blue borders on the edges of the polar caps as they melted,

and he stated that "water alone could do this." The author entirely disagrees with this interpretation, "the only proof," as he says, "he gives that the caps are frozen water." He points out that for water to be blue it must be deep, and this cannot be so on Mars because its surface is so level.

He finally indicates that there are two very important pieces of evidence which point to a lack of water vapour on the Martian planet—the spectroscopic evidence, which must be taken into account, entirely negatives the view of the presence of water vapour; and Dr. Johnstone Stoney's proof that aqueous vapour cannot exist permanently there, or on any planet, unless its mass is at least a quarter that of the earth. As the mass of Mars is only one-ninth that of our earth, the planet must have parted with its water vapour many, many centuries ago.

In the next chapter the important question of the probable temperature of the planet is taken in hand, and the author shows to his own satisfaction, and probably to that of the majority of his readers, that the temperature must be far too low for the possibility of any formation of a high form of organic life. He introduces also a note stating the view on this point given previously by Prof. J. H. Poynting, who showed that unless an assumption be made that there exists some quality in the atmosphere of Mars entirely different from any found in our own, the temperature of Mars cannot be as high as the value given to it by Prof. Lowell.

The author ingeniously considers the condition of the Martian atmosphere as being intermediate between that of the earth (a dense atmosphere) and that of the moon (practically no atmosphere). He then refers to many researches on lunar radiation as regards measurements made on portions of the surface exposed and unexposed to the sun's rays. He recalls the important function of a planetary atmosphere, like that, for instance, of our own earth, in retaining and cumulating solar heat and reducing radiation into space. He finally deduces that the Martian conditions of temperature must approximate more to those of the moon than to those of the earth. Further, he lays great stress on the impossibility of the seasonal change at the Martian poles being an apparent freezing and thawing of water, and he expresses his view in the following words:—

"If the moon, even at its equator, has not its temperature raised above the freezing point of water, how can the more *distant* Mars, with its *oblique* noon-day sun falling upon the snow-caps, receive heat enough, first to raise their temperatures to 32° F., and then to melt with marked rapidity the vast frozen plains of its polar regions?"

In the chapters referred to above the author has presented his views as to the extreme probability of a very low temperature and of the absence of water vapour on Mars, and consequently replies to the question "Is Mars Habitable?" in the negative.

In the remaining portion of the book he makes an alternative suggestion as to the cause or origin of the surface markings and changes recorded on the planet. Just as he stated he had to part company with Prof. Lowell when he considered the latter's deductions drawn from the discussion of his facts, so we must part company with Dr. Wallace, and disagree with his views on the peculiar, and what seems unique, origin of the planet Mars.

It may be recalled that Prof. W. H. Pickering, next to Prof. Lowell, has made the most minute study of the Martian surface details during the last decade or more. Further, he had the advantage of making his observations under practically similar climatic conditions, and, in addition, he has also closely studied the lunar features under specially fine instrumental and atmospheric conditions.

Prof. Pickering's suggested origin of the Martian canals is that they, like the rifts and streaks on the moon, are caused by volcanic action due to internal stresses set up by the cooling of the planet's heated interior. Dr. Wallace refers here to Prof. Pickering's work, and, like him, looks upon the canals and oases as the results of cooling.

In order, however, to create conditions on a planet which, when cooling, should be capable of producing an enormous network of fissures of large dimensions, and thus give a representation of the chief surface markings as seen on Mars, he suggests the following very ingenious but very questionable mode of planetary formation, rather straining even the very flexible meteoritic hypothesis.

He supposes that the planet began to be formed on the principle of the meteoritic hypothesis, but that the aggregation of the meteorites involved in the process took place so slowly that the heat generated by the bombardments was lost equally quickly by radiation. So gradual, he suggests, did this state of things occur that the planet attained its present size, minus about 50 to 100 miles of the radius, having grown to this dimension "as a solid and cold mass."

He then tells us that this cold mass, in its revolution round the sun, at a later stage of its life, passed through at each revolution a large and dense mass of meteorites. So violent were the impacts that the "inpour of the fresh matter first heated and later on liquefied the greater part of it, as well perhaps as a thin layer of the planet's original surface."

In this way the author produces a thin shell of liquid or plastic material covering a solid and cold interior, which he requires for the explanation of the surface features of Mars. At the termination of this series of annual bombardments this thin shell of heated material would rapidly cool, and, as it is superimposed on a globe of cool matter, craterlets would first be formed, and subsequently large fissures due to contraction. The fissures would have no regard for the equator, but would cross from one hemisphere to the other, as the canals are recorded to do.

The superficial tensions would render the cracks eventually very broad and deep, and where they crossed each other, holes, giving the appearance of oases, would be formed. In time, both fissures and oases would gradually crumble away at their sides, in consequence of the alternate expansion and contraction of the material, due to the presence or absence respectively of the sun's heat.

Although the author accounts for many of the other surface features and changes as recorded on the Martian disc, he is unable to suggest any satisfactory explanation of the doubling of the canals.

Enough, perhaps, has been said to indicate that in these pages we have some very original ideas on a subject of all-absorbing interest. It must nevertheless be left to the reader to form his own judgment as to the probability of the views put forward when he has carefully read the book.

We can unhesitatingly recommend this book to a very large circle of our readers, and more especially to those who have followed the previous publications relating to this subject. The last word on this difficult question has not been said yet, and the present issue will very likely re-kindle the flame.

WILLIAM J. S. LOCKYER.

AGRICULTURE IN FRANCE.

(1) *Races bovines. France—Étranger.* Pp. 426. Price 5 francs. (2) *Races chevalines.* Pp. viii + 467. Price 5 francs. By Prof. Paul Diffloth. Encyclopédie agricole. Zootechnie. (Paris: J. B. Baillière et Fils, 1908.)

IN the first of these volumes of the Encyclopedia Prof. Diffloth claims that special attention has been paid to varieties, to methods of selection and to breeding, and the author is to be congratulated on the success of his efforts. The book is a very valuable contribution to our knowledge of domesticated cattle; it treats, with commendable breadth and sufficient detail, not only of the characteristics of a great number of breeds and varieties of those breeds, but of certain of the physical conditions under which they thrive and of their geographical distribution.

Part i., which occupies thirty-four pages, begins with a short description of external features, head, body, limbs, teeth, horns, coat and colour, followed by brief notes on some of the anatomical variations which are specially marked in different races.

Part ii. fills the remainder of the book. The classification adopted by the author is based partly on Sanson's scheme of skull measurement, by which all species are divided into two main groups in accordance with the angle formed by a line drawn across the forehead at the base of the horns and a line from the base of one horn to the outer edge of the eye of the same side. When the angle so formed is a right angle, the type is recognised as brachycephalic, when it is obtuse as dolicocephalic. It is pointed out, however, that such classification is by no means a sufficient guide, and that various other external features, such as the form of the crest between the horns, the curve of the horns themselves, &c., must also be taken into account for practical purposes.

Twelve main races are recognised, and these are again subdivided into eighty-five varieties, as follows: —

(1) Low countries, with fifteen varieties; (2) German, three varieties; (3) Irish, five varieties; (4) Alpine, eight varieties; (5) Aquitaine, eight varieties; (6) Scythian, eight varieties; (7) Vendéenne, seven varieties; (8) Auvergnate, three varieties; (9) Jurassic, fourteen varieties; (10) Ibérique, six varieties; (11) Asiatic, seven varieties; (12) Scotch, represented only by the breed of that country.

Each variety is described; its origin, relation to other breeds, and the effects of crossing are discussed; its special capabilities are examined; the physical conditions of the geographical area it inhabits are generally noted, and their possible effect upon the breed is referred to.

A series of seven maps is of special interest. They are designed to show the areas over which certain races and varieties range, and in some cases their special breeding area is further distinguished. With two exceptions these maps refer to French breeds, the Dutch and Austro-Hungarian races being the only others so treated. This scheme is a most suggestive one, and if consistently carried out would be a very valuable aid both to the student and the practical breeder.

The text is full of valuable information concisely and clearly presented, especially valuable to English readers where it treats of French breeds. Besides figures in the text, many of which leave very much to be desired, there are forty plates, photogravures of selected animals.

The space at our disposal allows of only a very brief notice of the second volume. This book is equally carefully compiled, and is a valuable aid to the student, especially in relation to the natural conditions under which the various races and varieties of the horse thrive.

The author's classification scheme will not, perhaps, satisfy many authorities, but his descriptions of the characteristics of the very numerous varieties he recognises are clear and unbiased, and the figures and plates are good.

His statistics regarding the horse population of the world are no doubt open to criticism, but they cannot be questioned in relation to the conclusion he draws that the advent of the motor-car and agricultural machinery has been followed by an increase both in the numbers and value of horses. The view that Government aid is necessary for the breeding of certain classes of horses in this country receives substantial support from the author's description of the results gained by the care given and the large sums expended by his own Government for this purpose. Short chapters on the ass and the mules conclude the volume.

CHEMISTRY IN THE SEVENTEENTH CENTURY.

Medico-Physical Works of John Mayow (1674). Pp. xxiii + 331; with 6 plates. (Edinburgh: The Alembic Club, 1907.)

ALTHOUGH the name of John Mayow is well known to chemists, there are few who are acquainted with his works. Even the majority of the historians of chemistry have been content to acquire